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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/856,209	05/18/2001	Kozo Nakamura	82822	6736

7590 10/15/2002

Welsh & Katz
120 South Riverside Plaza
22nd Floor
Chicago, IL 60606-3913

EXAMINER	
SONG, MATTHEW J	
ART UNIT	PAPER NUMBER
1765	6

DATE MAILED: 10/15/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/856,209	NAKAMURA ET AL.
	Examiner	**Art Unit**
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sh et with the correspondence address --

Period f r R ply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-14 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-14 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 1 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 1 recites the limitation of "adjusting only temperature parameters during pulling"; the instant specification does not support this limitation. Page 3 of the instant specification states "by adjusting parameters during pulling", not only temperature parameters. Also page 11 of the instant specification states there is a correlation between pulling speed and the temperature gradient in the crystal.

3. Claims 10, 11 and 14 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 10 recites the limitation of "$1.15 < G1_{edge}/VG1_{center} \leq 1.25$", there is no support for this limitation in the instant specification.

4. Claims 1 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The specification does not set forth a method to produce a "perfectly crystalline part", one free of all defects. Applicant's own definition of perfectly crystalline is unclear, as to if all or just the stated defects are removed. Applicants have shown a process to remove the stated defects but this does not teach one of ordinary skill in the art to remove all defects, as the definition is open to include all defects. However, it is well settled in the Czochralski growth art that all crystals made with have some defect in it. The defects can range from point defects, lattice vacancies, strains and dislocations, note Chapter 5 of Zulehner and Huber. Therefore, applicant has not enabled the process for all dislocations and must show that the produced crystal is indeed "perfect" and free of any and all defects.

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claim 11 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The purpose of the quotation marks in line 3 is indefinite.

Claim Objections

7. Claim 11 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the

claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 11 recites the limitation of "$1.15 \leq G1_{edge}/G1_{center} \leq 1.25$", the examiner has interpreted claim 10 to read as $1.15 \leq G1_{edge}/G1_{center} \leq 1.25$, therefore claim 11 fails to further limit claim 10.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

11. Claims 1- 2 and 4-14 are rejected under 35 U.S.C. 102(e) as being anticipated by Iida et al (US 5,968,264).

In a method of manufacturing a crystal ingot, note entire reference, Iida teaches a silicon single crystal grown through the use of a crystal pulling apparatus, where wafers were sliced

from the thus-obtained silicon ingot (col 14, ln 20-67). Iida also teaches (Delta G=G_e-G_c) is not greater than 5°C/cm, where G_e is a temperature gradient at the periphery and G_c is a temperature gradient at the center portion of a growing crystal (col 10, ln 5-15). Iida also teaches a G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm)(Fig 8), where the G_e/G_c ratio can be determined to be 1.16. Iida also discloses that wafers were sliced from the thus-obtained silicon ingot (col 14, ln 20-67) Iida also teaches an OSF region is observed between a N region, a neutral region having few defects, and a vacancy rich region and interstitial rich region (col 15, ln 1-15 and Fig 10A) Iida also teaches the G_c is the temperature gradient at a central portion of the growing crystal both in an in-crystal descending zone, 1300-1000°C, or in the vicinity of the solid-liquid interface of the crystal, melting point of silicon to 1400°C (col 4, ln 5-15 and col 4, ln 35-39), therefore G_c reads on applicant's $G1_{center}$ and $G2_{center}$. The value of 1.06x ($G1_{center}$ and $G2_{center}$)$^{-0.2}$ can be determined to be 0.68. Iida also teaches an OSF ring with an inner diameter of at least ½ a wafer inner diameter (Fig 10A) at a pulling speed of 0.62 mm/min.

Referring to claim 1, Iida et al teaches adjusting a temperature gradient at the periphery and a temperature gradient at the center to obtain a neutral region having few defects, this reads on applicant's perfectly crystalline part such that an OSF ring appears at a prescribed position in the silicon single crystal and a part of the ingot is improved and Iida et al teaches controlling the temperature gradient at the edge and a temperature gradient at the center, which reads on applicant's controlling only temperature parameters.

Referring to claim 2, Iida et al teaches G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm)(Fig 8), where the G_e/G_c ratio can be determined to be 1.16.

Referring to claim 4, Iida et al teaches a pulling speed of an ingot is changed (Example 1).

Referring to claim 5, Iida et al teaches an OSF ring an inner diameter of which is 70% or less of an overall diameter and which there exists, surrounding the OSF ring a defect free zone occupying 50% or more of a total surface area on one side (Fig 10a).

Referring to claim 6, Iida et al teaches an OSF ring an inner diameter of which is 50% or less of an overall diameter and which there exists, surrounding the OSF ring a defect free zone occupying 75% or more of a total surface area on one side (Fig 10a).

Referring to claim 7, Iida teaches a similar silicon ingot as applicant's ingot of claim 7, it is noted that claim 7 is a product by process relationship and it is the applicant's burden to show an unobvious difference. Iida et al teaches a silicon ingot pulled by a CZ method under conditions similar to applicant.

Referring to claim 8, Iida et al teaches in Fig 10A an OSF ring with an inner diameter of at least ½ a wafer inner diameter at a pulling speed of 0.62 mm/min for silicon ingot and wafers are sliced from said ingot.

Referring to claim 9, Iida et al teaches G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm)(Fig 8), where the G_e/G_c ratio can be determined to be 1.16 and a OSF ring occupying to crystal diameter ratio of greater than 0.5 and less than $1.06x(G1_{center} \times G2_{center})^{-0.2}$ in Fig 10A.

Referring to claim 10, Iida et al teaches G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm)(Fig 8), where the G_e/G_c ratio can be determined to be 1.16, where the examiner has interpreted claim 10 to read as $1.15 \leq G1_{edge}/G1_{center} \leq 1.25$ and a OSF ring at least ½ a wafer inner diameter (Fig 10A).

Referring to claim 11, Iida teaches a G_c=30°C/cm (3.0 °C/mm) and a G_e=35°C/cm (3.5 °C/mm), where G_e/G_c can be determined to be 1.16.

Referring to claim 12, Iida et al teaches the inner diameter of an OSF region increases as the pulling rate increases (Fig 10A). It is inherent to Iida's invention to reduce the density of void defects existing on the inside of an OSF ring because Iida teaches a similar increase in diameter of the OSF ring.

Referring to claim 13, Iida et al teaches controlling a ratio of an OSF ring inner diameter to a crystal diameter (Fig 10A), and a controlling a temperature gradient at the edge and at the center in a range similar to the range taught by applicant.

Referring to claim 14, Iida et al teaches a density of void defects existing on the inside of an OSF ring reduced by expanding the inner diameter of the OSF ring in Fig 10A.

10. Claims 2, 4-6 and 10-14 are rejected under 35 U.S.C. 102(e) as being anticipated by Hourai et al (US 5,954,873).

In a method to produce silicon single crystal wafers essentially defect-free, Hourai et al. teaches the V/G ratio is maintained at 0.20-0.22 mm^2/°C.min at the center of the crystal and V/G ratio is maintained at 0.20-0.33 mm^2/°C.min at the outer surface of the crystal, where V is the pulling rate (mm/min) and G is the temperature gradient (mm/°C) (col 3, ln 41-57). Hourai et al also teaches the diameter of the OSF ring can be controlled by the single crystal pulling rate and the inside-crystal temperature gradient in the axial direction in a high temperature zone from the melting point of silicon to 1300°C (col 4, ln 43-57). Hourai teaches the OSF ring develops at the intermediate positions with a no-defect region, this reads on applicant's limitation of perfectly

crystalline part, formed outside the ring and a scattering faults develop inside the ring at slower pulling rates and the OSF ring develops at the periphery at higher rates. (col 6, ln 1-20 and Fig 1A) Hourai also teaches the pulling rate is changed as the crystal is pulled to compensate for changes in the temperature gradient to maintain a constant V/G (col 6, ln 47-65) Hourai also discloses for medium velocity pulling a OSF ring develops at about one half the distance from the center of the silicon single crystal wafer (col 2, ln 1-8) Hourai teaches in Fig 4 a no defect region surrounding a OSF ring at various lengths of a silicon ingot.

Referring to claim 2, the ratio of G_{outer}/G_{center} can be determined by the ratio of V/G for the outer surface and the V/G of the center. The G_{outer}/G_{center} can be determined to be 1.1 for the ratio of 0.22/0.20.

Referring to claim 4, Hourai et al teaches the pulling rate is changed as the crystal is pulled to compensate for changes in the temperature gradient to maintain a constant V/G.

Referring to claim 5-6, Hourai et al teaches a similar method of producing a silicon single crystal, therefore it is inherent that the wafer has a OSF ring inner diameter of 50% or less and a defect free zone occupying 75% or more of the total surface area.

Referring to claim 10, Hourai et al teaches a similar method of pulling a silicon ingot, therefore it is inherent that an OSF ring is at least ½ a wafer inner diameter.

Referring to claim 12 and 14, Hourai teaches the OSF ring diameter varies depending on the pulling rate and the diameter shrinks with decreasing pulling rates and Fig 4 illustrates the expanding of an OSF ring. It is inherent to Hourai's invention that the density of void defects would decrease because Hourai et al teaches a similar increase in the diameter of the OSF ring diameter.

Referring to claim 13, Hourai et al teaches controlling a ratio of OSF ring inner diameter to a crystal diameter (Fig 4) and thermal gradients at the edge and center of an ingot.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. Claims 1 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873).

Hourai et al discloses all of the limitations of claim 1, as discussed previously in claim 2, except Hourai et al does not teach adjusting temperature parameters only. Hourai et al teaches a constant pulling rate of 0.45 mm/min (col 7, ln 20-30). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai et al by adjusting temperature parameters to maintain a V/G ratio of 0.2-0.33 $mm^2/°C$ min for a constant pulling rate 0.45.

14. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al. (US 5,954,873) or Iida et al (US 5,968,264) as applied to claim 2 above, and further in view of Luter et al. (US 5,922,127).

Hourai et al or Iida et al teaches all of the limitations of claim 3, as discussed previously in claim 2, except the single crystal ingot production is preformed while adjusting a distance between the silicon melt and a heat-shield member installed in a Czochralski method silicon crystal production equipment.

In an apparatus for pulling single crystals, Luter teaches a crucible mounted on a motorized turntable which raises the crucible to maintain the surface of the molten source material at a constant level as the ingot grows and the source material is removed from the melt (col 3, ln 60-65) Luter also teaches a heat shield (40) mounted above the upper surface of the molten source material (col 4, ln 32-37). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai et al or Iida et al with Luter to avoid undesired changes in the thermal profile during the growth process.

Response to Arguments

15. Applicant's arguments filed 8/19/2002 have been fully considered but they are not persuasive.

The arguments regarding the Iida et al reference and Hourai et al reference are not deemed persuasive. It is not fully understood why one of ordinary skill in the art would perform the complicated mathematical calculations in applicant's argument, when one of ordinary skill in the art can determine the ratio of $G1_{edge}/G1_{center}$ by using the temperature gradients disclosed by Iida et al. Iida et al discloses a G_c=3.0 °C/mm and a G_e=3.5 °C/mm and the ratio can merely be determined by division, which leads to a ratio of 1.16, which is within the instant application's

claimed range. Hourai et al and Iida et al teaches a ratio of $G1_{edge}/G1_{center}$ within in the range claimed by applicant, therefore the rejection is deemed proper.

Applicant's arguments with respect to claim 1 in regards to Hourai et al have been considered but are found to be obvious to one of ordinary skill in that art at the time of the invention. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai et al by adjusting only temperature parameters for a constant pulling rate to control the diameter of an OSF ring to maintain a V/G ratio of 0.2-0.33 $mm^2/°C$ min as taught previously by Hourai et al.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
October 9, 2002